DESCRIPTION

CONSTRUCTION OF WALL OPENING IN STEEL HOUSE

Technical Field

This invention relates to a construction of a wall opening in a steel house.

Background Art

A steel house can be defined as a 2x4 (two-by-four) house of iron skeletal frames having a steel type panel construction constituted by frame members and structural face members each made of thin light-weight shape steel having a sheet thickness of about 1 mm.

The frame members of such a steel house are shaped into sectional shapes such as a groove shape, a groove shape with lips and a box shape by roll-forming a thin steel sheet. The frame members are shaped in such a fashion that their width satisfies a predetermined specification. To execute working of the steel house, it is customary to fasten a plurality of frame members by drill screws to constitute reinforcing frame members and to constitute a main erection structure by bonding these members by drill screws.

Next, the construction of a steel house by a construction method for a steel house according to the prior art will be explained with reference to Figs. 7 to 9.

To build the steel house, a plurality of longitudinal frame members 2 are rised with predetermined gaps between them at lower frame members 1 as shown in Fig. 7. The upper end of each longitudinal frame member 2 is interconnected to the upper ends of other frame members 2 through an upper frame member 3. Structural face members 7 are fixed to wall frame members constituted by the lower frame members 1, the longitudinal frame members 2 and the upper frame members

3 through drill screws 23 as shown in Fig. 9. Openings 8 such as entrances and exits 8a and windows 8b are formed in this steel house.

Side floor joists 5a and end floor joists 5b are supported by the upper frame members 3 to which the structural face members 7 are fitted, and both of these floor joists 5a and 5b are assembled into a rectangular shape. A plurality of floor joists 10 is arranged, with predetermined gaps between the joists, in parallel with the side floor joists 5a and both ends of each elongated floor joist 10 are connected to the front or rear end floor joist 5b or floor beams 12 by bracket metals 11. One of the ends of each short floor joist 10 is connected to the front or rear end floor joist 5b and the other end, to the floor beam 12 (or to a cleat 10d) through the bracket metals 11 (or a floor joist bracket metal 10c), respectively. One of the ends of each floor joist 10b on the opening side is connected to the end floor joist 10 and the other end, to the floor joist 10a on the floor opening side. The structural face member 13 is fitted to a floor frame member 14 constituted by these floor joists 10 and floor beams 12.

Incidentally, longitudinal frame members 2 do not exist in the openings 8 such as the entrances and exits 8a and 8b of this steel house. Because the support poles in the longitudinal direction for supporting the vertical load from the upper floor such as a roof do not exist in the openings 8, therefore, the openings 8 are low in strength. A lintel 15 is therefore arranged above each opening 8 to reinforce the upper part of the opening 8.

Fig. 8 shows the detail of the fitting position of the lintel 15. As shown in this Fig. 8, an upper frame member 3 and a lintel frame member 17 are arranged above and below the window 8b (opening 8) and a lintel longitudinal frame member 19 is interposed between the lintel frame member 17 and the opening upper frame member 18. Both ends of the lintel 15 are fixed to lintel

receptacles 20 through lintel metal bracket 21. Each lintel receptacle 20 is fixed to a longitudinal frame member 22 for accepting and fitting the lintel. The lower and upper ends of this longitudinal frame member 22 for accepting and fitting the lintel are fixed to the lower frame member 1 and to the upper frame member 3 through the drill screws 23. The opening lower frame member 24 is supported at is lower end by the upper end of the opening lower longitudinal frame member 25 the lower end of which is fixed to the lower frame member 1 or through a bracket 24a.

Incidentally, a structural face member is fixed by the drill screws 23 to the opening lower frame member 24 and each frame member arranged above the former to constitute a vertical wall 26 as shown in Fig. 9. A structural face member is fixed by the drill screws 23 to the opening lower frame member 24 and each frame member arranged below the former to constitute a wainscot wall 27 as shown in Fig. 9. Further, the structural face members 23 are fixed to the longitudinal frame members 22 for accepting and fitting the lintel and to the frame members (longitudinal frame members 2a) on both outer sides of this frame member 22 by the drill screws 23 to form each side face wall 28.

Incidentally, because the support poles do not exist inside the opening 8, the four sides of the opening upper frame member 18, the opening lower frame member 24 and the longitudinal frame 22 for accepting and fitting the lintel undergo displacement in the horizontal direction when a stress in the horizontal direction, due to a earthquake and so forth, acts on them. When the vertical wall 26, the wainscot wall 27 and the side wall 28 are rigidly coupled with one another during such horizontal displacement, each wall operates as a strong wall and the displacement of the frame members around the opening 8 can be suppressed.

According to the prior art, however, the vertical

wall 26, the wainscot wall 27 and the side wall 28 are loosely coupled with one another so that displacement does not occur among these walls. Figs. 10 and 11 show the behavior when the horizontal force is applied to the vertical wall 26, the wainscot wall 27 and the side face wall 28 according to the prior art. As shown in Figs. 10 and 11, the side wall 28 rocks due to the horizontal force that is applied. Because the side face wall 28 is loosely coupled with the vertical wall 26 and the wainscot wall 27, however, the horizontal force is not transmitted to these walls 26 and 27. In other words, the horizontal force applied to the periphery of the opening 8 is substantially fully borne by the side face wall 28 and is offset through rocking of such a side face wall 28.

Incidentally, a "Wall Structure and Face Member Bonding Method" that deviates the joint portions of face members of side walls (wing walls) from the positions of plywood of vertical walls has been proposed in the past (for example, Japanese Unexamined Patent Publication (Kokai) No. 2000-234406). A "Calculation Method of Wooden Houses and Wooden Houses Using the Method" has also been proposed (for example, Japanese Unexamined Patent Publication No. 2001-164645).

Disclosure of the Invention

In the example described above and shown in Figs. 10 and 11, the side face walls 28 disposed on both sides of the opening 8 are spaced apart from the vertical walls 26 positioned above and below the opening 8 and from the wainscot wall 27. For this reason, each side face wall 28 has a small resistance to rocking in the horizontal direction, due to the earthquake, etc, so that the quantity of deformation in the horizontal direction becomes great. Furthermore, a pull force represented by a downward vector as indicated by arrows in Fig. 11, a compressive force represented by an upward vector, a

rightward force and a leftward force operate alternately and in a cycle.

In other words, the forces operating in these directions mutually have the relation of action and reaction and maintain a mutual balance. Therefore, the greater the magnitude of rocking in the transverse direction, the greater becomes the pull force and the compressive force. The pull force, in particular, is the sum of the vector amounts in the ellipse (X) of dotted line in Fig. 11. Therefore, when this pull force becomes great, the compressive force becomes great, too. To cope with the increase of this pull force (compressive force), the size of the longitudinal frame member for fitting the side face wall 28 must be increased and the size of hold-down metals for fitting the longitudinal frame member to the foundation, etc, must be increased to make them more rigid. Furthermore, anchors for fixing the hold-down metals to the concrete foundation must be thicker to improve the strength.

When the hold-down metal is made large in size to cope with such a pull force (compressive force), however, the strength of the structure itself around the opening 8 can be increased but when the steel house is considered as a whole, a structure having a high strength is arranged only at a part. Therefore, when a large horizontal force is applied to the steel house, due to an earthquake, etc, the stress concentrates on the periphery of the opening reinforced to a high level and a large load is also applied to other structural members. When such structural members are similarly fixed and reinforced separately by reinforcing members, the reinforcing members are eventually arranged throughout the entire steel house and this is not reasonable from the production cost and the labor.

Fig. 12 shows the relation of the shearing strength with respect to the shearing deformation amount of the side walls 28 arranged on both sides of the opening 8.

As shown in Fig. 12, when the construction in which the side face walls 28 are separated from the vertical wall 26 and the wainscot wall 27 positioned above and below the opening 8 as shown in Fig. 12 is employed, the shearing stress gradually becomes great with the shearing deformation amount as indicated by p in the drawing. In contrast, when the frame members around the opening 8 are reinforced by the hold-down metals, or the like, the initial rigidity can be improved as indicated by q in the drawing but the shearing stress greatly increases.

Therefore, it has been necessary to eliminate the stress concentration inside the steel house by keeping the shearing stress at a low level while the initial rigidity is kept at a high level as indicated by the behavior r of the frame members around the opening 8.

The invention has been completed in view of the problems described above and an object of the invention is to provide a reinforcing construction of an opening wall in a steel house capable of suppressing shearing stress to a low level while keeping, especially, the initial rigidity at a high level. In this construction, each side face wall is so arranged as to be clamped between a vertical wall panel and a wainscot panel, an opening upper frame member to which a lower end of the vertical panel is fixed and an opening lower frame member to which an upper end of the wainscot panel is fixed are fixed through joint metals 81 to each transverse frame member constituting a side face wall frame member to which the side face wall is fixed.

In other words, a construction of an opening wall in a steel house to which the invention is applied comprises two side face wall frame members, a vertical panel and a wainscot panel; each of the side face wall frame members comprising an opening formed by an opening upper frame member to which a lower end of the vertical panel is fixed, an opening lower frame member to which an upper end of the wainscot panel is fixed, two longitudinal

frame members implanted on both sides of the frame members, outer longitudinal frame members implanted outside the longitudinal frame members, respectively, and transverse frame members for supporting portions between upper ends and lower ends of the longitudinal frame members and the outer longitudinal frame members, respectively; wherein face members constituting the wainscot panel are extended to and integrated with upper parts of side face walls, face members constituting the wainscot panel are extended to and integrated with lower parts of the side face wall, and the face members of the side face wall on the side of the opening are divided.

Brief Description of the Drawings

Fig. 1 is a perspective view of a reinforcing construction to which the invention is applied.

Fig. 2 is an explanatory view for explaining a framework of the reinforcing construction to which the invention is applied.

Fig. 3 is an explanatory view for explaining the arrangement position of each wall panel in the reinforcing construction to which the invention is applied.

Fig. 4 is an explanatory view for explaining a behavior when horizontal force acts on the reinforcing construction.

Fig. 5 is another explanatory view for explaining the behavior when the horizontal force acts on the reinforcing construction.

Fig. 6 shows the relation of shearing stress with a shearing deformation amount of side walls arranged on both sides of an opening.

Fig. 7 is an explanatory view for explaining a construction of a steel house.

Fig. 8 shows the detail of lintel fitting positions.

Fig. 9 is an explanatory view for explaining each fixing position of a structural face member.

Fig. 10 is a view showing a behavior when a horizontal force acts on a vertical wall, a wainscot wall and a side face wall according to the prior art.

Fig. 11 is another view showing a behavior when horizontal force acts on a vertical wall, a wainscot wall and a side face wall according to the prior art.

Fig. 12 is an explanatory view for explaining problems of the invention.

Best Mode for Carrying Out the Invention

A reinforcing construction of a wall opening in a steel house will be hereinafter explained in detail with reference to the accompanying drawings as the best mode for carrying out the invention.

A reinforcing construction 50, to which the invention is applied, is a construction for reinforcing an opening 51 as typified by an entrance-and-exit of the steel house as shown in Figs. 1 to 3. As the framework of this reinforcing construction 50, a plurality of shape frame members 53 are implanted with predetermined gaps among them from lower frame members 52 as shown in Figs. 1 and 2 and the upper end of each shape frame member 53 is fixed to an opening lower frame member 54. A plurality of shape frame members 56 is implanted with predetermined gaps among them from upper frame members 55 and the lower end of each shape frame member 56 is fixed to an opening upper frame member 57.

Side face wall frame members 64 are formed on both sides of an opening 51. Each side face wall member 64 comprises a longitudinal frame member 58 implanted on each side of the opening 51 defined between the opening upper frame member 57 and the opening lower frame member 54, an outer longitudinal member 59 arranged outside each longitudinal frame member 58, a transverse frame member 61 arranged to support the longitudinal frame member 58 and the outer longitudinal frame member 59, and a transverse frame member 62 arranged to support the

longitudinal frame member 58 and the outer longitudinal frame member 59.

In this reinforcing construction 50, longitudinal frame members 121 having a rectangular sectional shape are arranged to extend from the lower frame member 52 to the upper frame member 55. An intermediate longitudinal frame member 131 is arranged between the longitudinal frame member 121 and the outer longitudinal frame member 59 in such a fashion as to extend from the lower frame member 52 to the upper frame member 55. Incidentally, each outer longitudinal frame member 59 may be arranged to similarly extend from the lower frame member 52 to the upper frame member 55.

Side face upper frame members 157 are further arranged at both ends of each opening upper frame member 57 and side face lower frame members 154 are arranged at both ends of each opening lower frame member 54. In other words, the opening upper frame member 57 and the side face upper frame member 157 and the opening lower frame member 54 and the side surface lower frame member 154 are arranged in a mutually split form at the same height. A notch, not shown in the drawings, for inserting a plate, not shown, for supporting the opening upper frame member 57 and the side face upper frame member 157 or a plate, not shown, for supporting the opening lower frame member 54 and the side surface lower frame member 154 may be formed in the longitudinal frame member 121.

A vertical wall panel 71 such as one shown in Fig. 3 is fitted to each of the upper frame member 55, the opening upper frame member 57 and the side face upper frame member 157. A wainscot panel 72 is fitted to each of the opening lower frame member 54, the side face lower frame member 154 and the lower frame member 52. In other words, the lower end portion of the wainscot panel 71 is fixed to the opening upper frame 57 and the upper end portion of the wainscot panel 72 is fixed to the opening

lower frame member 54. Incidentally, both ends of the vertical wall panel 71 and the wainscot panel 72 may be extended to positions near the formation position of the outer longitudinal frame member 59.

A side face wall 73 is fitted to a side surface wall frame member 64. The side face surface wall 73 is fixed in such a manner as to be clamped between the vertical wall panel 71 and the wainscot panel 72 as shown in Fig. 3.

Each frame member is formed of a channel that is produced by bending a thin steel sheet having a thickness of about 1.0 mm to about 1.6 mm so that a web and flanges at both ends of the web continue integrally. The lower frame member 52 is constituted by a web 52a and flanges 52b formed on both sides of the web 52a as shown in Fig. 1. The shape frame member 53 including a web 53a, flanges 53b on both sides of the web and lips 53c at the distal end of the flanges 53b is inserted into the lower frame member 52 substantially from the vertical direction. Drill screws, not shown, are set to their overlapping portions to bond these members with one another. Similarly, the opening lower frame member 54 is constituted by a web 54a and flanges 54b arranged on both sides of the web 54a and the frame member 53 is inserted into the opening lower frame member 54 substantially from the vertical direction.

The backs of the rear surfaces of the side face lower frame member 154 and the transverse frame member 62 are bonded to each other in such a fashion that the section describes substantially an H shape. Joint metals 81 such as drill screws are struck to the side surface lower frame member 154 and the transverse frame member 62 to bond them together. In consequence, the side wall portion of the vertical panel 71 or the wainscot panel 72 is fixed by the joint metals 81.

The joint metal 81 is not limited to the drill screw but may be constituted by any fastening member such as a

bolt-and-nut. Any other bonding means such as welding may also be employed instead of mounting the metal joint 81.

Similarly, the side face upper frame member 157 constituted by the web 157a and the flanges 157b disposed on both sides of the web 157a is formed by bonding its rear surface to the rear surface of the transverse frame member 61 constituted by the web 61a and the flanges 61b in such a fashion that the section describes substantially an H shape. The metal joint 81 is connected to the side face upper frame member 157 and the transverse frame 61 that are so bonded.

Next, the behavior of a steel house, having the reinforcing construction 50 described above, when the horizontal force is applied will be explained.

First, when applied to the steel house, the horizontal force is transmitted to the reinforcing construction 50 with the result that the entire reinforcing construction 50 undergoes deformation in the horizontal direction. In the reinforcing construction 50 according to the invention, however, the length of the side face wall 73 is smaller than that of the reinforcing construction of the opening according to the prior art and the initial rigidity itself of the side face wall 73 becomes great. As a result, the deflection amount itself of the side face wall 73 is small as shown in Fig. 4 when the horizontal force applied is small. However, the portions having low strength in the reinforcing construction 50 are affected by the horizontal force and the metal joint 81 connecting to the flanges 61a, 62a of the transverse frames 61 and 62 to which the side face wall 73 is fixed, in particular, undergo elastic deformation or plastic deformation in the horizontal direction owing to such a horizontal force.

In other words, in comparison with the construction of the prior art, this construction can suppress the deformation of the side face walls. Therefore, even when

slight vibration is imparted to the steel house, the construction can suppress the vibration.

In this reinforcing construction 50, in particular, the side face wall 73 is interconnected to the vertical wall panel 71 and the wainscot panel 72 through the joint metals 81. Therefore, even when the horizontal force acts on such a reinforcing construction 50, the vertical wall panel and the wainscot panel can bear the horizontal force to a certain extent and deformation of the side face wall 73 is much more restricted. In other words, the vertical wall panel 71 and the wainscot panel 72 that are interconnected reduce the stress applied to the side face wall 73 and the section of the side face wall 73 can be made smaller.

When the large horizontal force acts on this reinforcing construction 50 owing to the earthquake, etc, too, the construction does break instantaneously, as shown in Fig. 5, because the side face wall 73 has high initial rigidity. When the portions of the reinforcing construction 50 that have low strength bear the horizontal force, the drill screws 23 (metal joint) connected to the flanges 61a and 62a of the transverse frame members 61 and 62 to which the face members of the side face walls 73 are fixed undergo deformation due to the horizontal force and eventually, the joint portions of these drill screws 23 are broken. Breakage of the drill screws 23 eventually invites lowering of the breaking stress of the reinforcing construction 50 as a whole.

In other words, this reinforcing construction does not much improve the final shearing stress in comparison with the prior art technology when the large horizontal force is applied, due to an earthquake, etc., but can prevent the state where a structure having a high strength is disposed at only a part of the entire steel house. Therefore, when the large horizontal force of an earthquake, etc., is applied to the steel house, the

stress does not concentrate on the reinforcing construction 50 around the opening and a large load is not applied to other structural members, either.

Fig. 6 shows the relation of the shearing stress with the shearing deformation amount of the side face walls arranged on both sides of the opening. In comparison with the behavior t of the prior art, the behavior u of the reinforcing construction 50 according to the invention can suppress an increase in the shearing stress while keeping the initial rigidity at the high level. Therefore, the reinforcing construction 50 can suppress a local concentration of the stress inside the steel house. Because reinforcing members need not be provided separately to each constituent member of the steel house to cope with such a stress concentration, the production cost and the amount of labor can be reduced.

In the embodiment described above, the invention has been limitedly explained with reference the reinforcing construction 50 of the opening 51 constituting the windows and the entrances and exits of the steel house by way of example, but is not specifically limited to such portions and can of course be applied to any opening in the steel house.

Industrial Applicability

According to the invention, the side face wall is arranged in such a fashion as to be clamped between the vertical wall panel and the wainscot panel, and the opening upper frame member to which the lower end of the vertical panel is fixed and the opening lower frame member to which the upper end of the wainscot panel is fixed are fixed through the joint metals to each transverse frame member constituting the side face wall frame body to which the side face wall is fixed. Consequently, the invention can limit the shearing stress to a low level while keeping the initial rigidity at a high level.